The Influence of Platelet Ice and Snow on Antarctic Land-fast Sea Ice

C23A-0483

Mario Hoppmann[1,2] Mario.Hoppmann@awi.de

Marcel Nicolaus[1] Marcel.Nicolaus@awi.de

[1]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

[2]Jacobs University Bremen, Germany

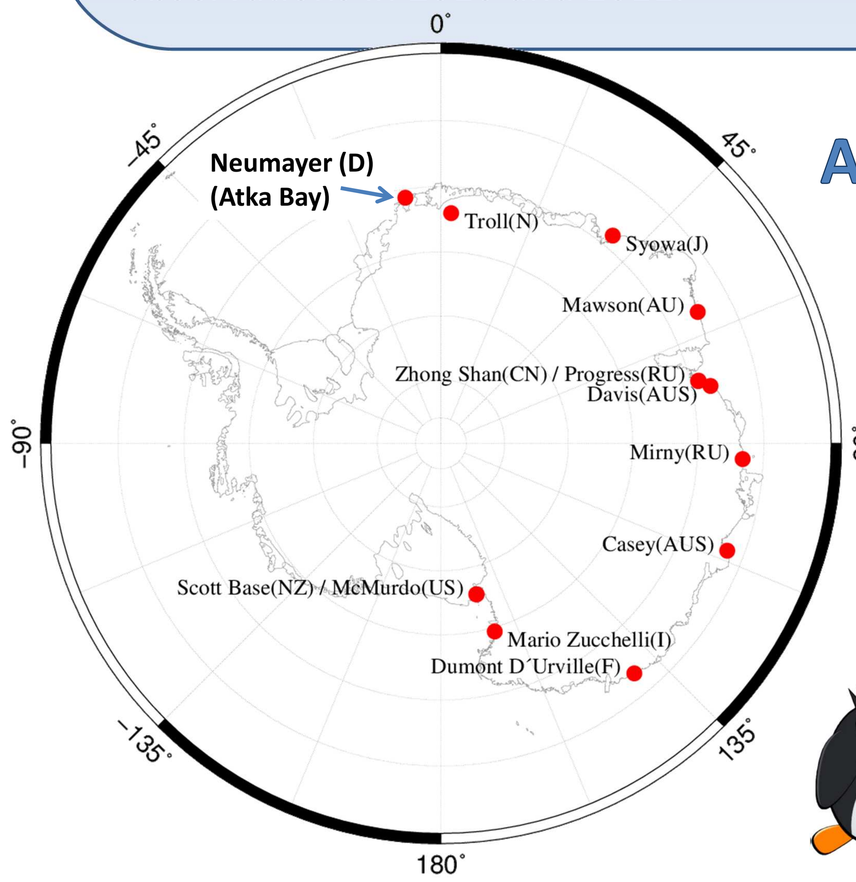
Introduction

Sea ice fastened to coasts, icebergs and ice shelves is of crucial importance for **climate- and ecosystems**. Near Antarctic ice shelves, this land-fast sea ice exhibits two unique characteristics that distinguish it from most other sea ice:

1) **Ice platelets** form and grow in super-cooled water, which originates from ice shelf cavities. The crystals accumulate beneath the solid sea-ice cover and are incorporated into the sea-ice fabric, contributing between 10 and 60% to the mass of the land-fast sea ice around Antarctica.

2) A thick and partly multi-year **snow cover** accumulates on the fast ice, altering the sea-ice surface and affecting the **sea-ice energy and mass balance**.

In order to investigate the role and the spatial and temporal variability of platelet ice and snow for Antarctic fast ice, we perform **regular field measurements** on the land-fast sea ice of Atka Bay as part of the international Antarctic Fast Ice Network (AFIN). Here we present the results of our observations in 2010 and 2011.



Antarctic Fast Ice Network

- **International network** of fast-ice monitoring stations around the Antarctic coastline, established in 2007 [Heil et al. 2011]
- Measurements include ice and snow thicknesses, freeboard, dates of fast-ice formation and (intermittent and final) breakout, as well as meteorological and oceanic parameters
- Provides online data access

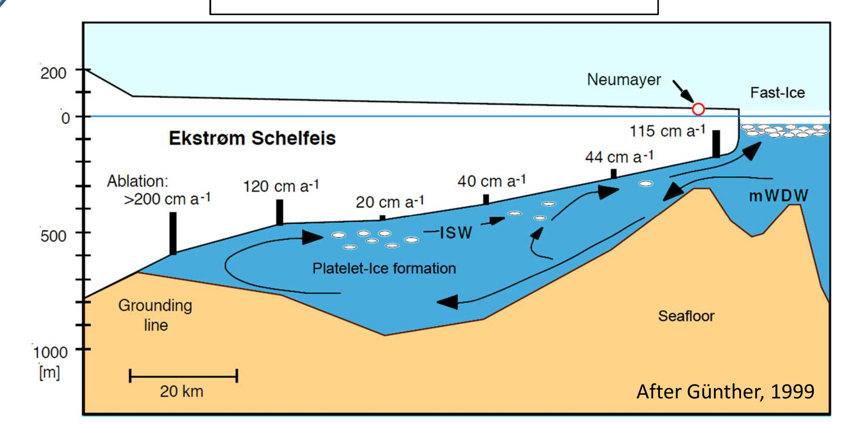
Summary and Perspective

- Ice platelets are often observed under Atka Bay fast ice
- Platelet ice contributes significantly to sea-ice formation and processes
- The high variability of ice platelets strongly influences the spatial and temporal variability of fast-ice mass balance in Atka Bay
- Wind and currents lead to thicker ice in the West with high local variability
- Snow cover is very heterogeneous throughout the entire Bay
- Negative freeboard leads to extensive surface flooding
- Freezing model supports the observations and results from previous studies

- In 2012, additional autonomous observations of radiation and sea-ice mass balance will be added
- Extension of observational program through ice-thickness transects by EM methods and ice coring for texture analysis
- We will perform an additional field campaign in Nov/Dec 2012, including observations with an under-ice platelet-ice camera, extensive snow transects (thickness & properties), and CTD profiles

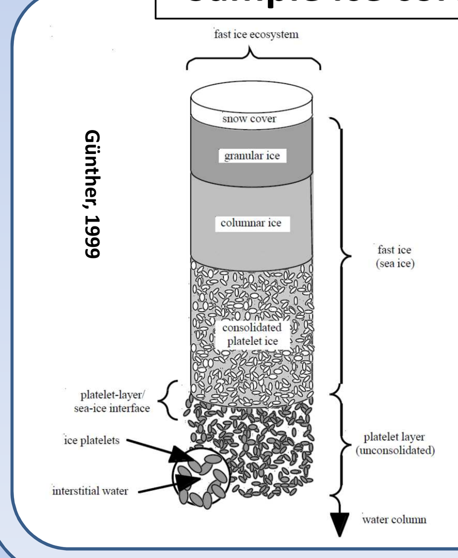
A platelet puzzle in Antarctica

Platelet ice formation



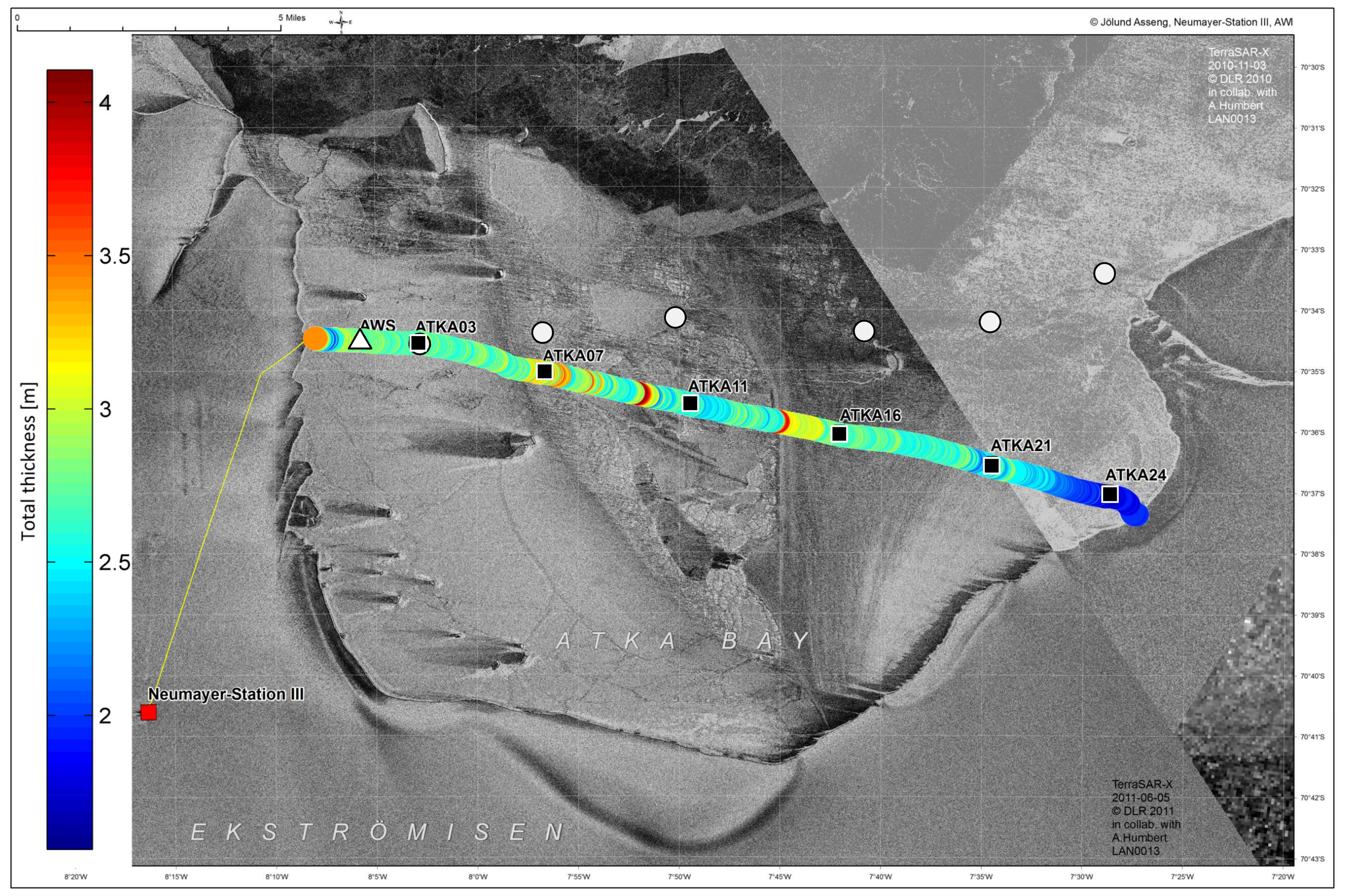
Interaction of ocean with base of Ekström Ice Shelf leads to **supercooled water masses**, where ice platelets form and accumulate below land-fast ice.

Sample ice core from Atka Bay



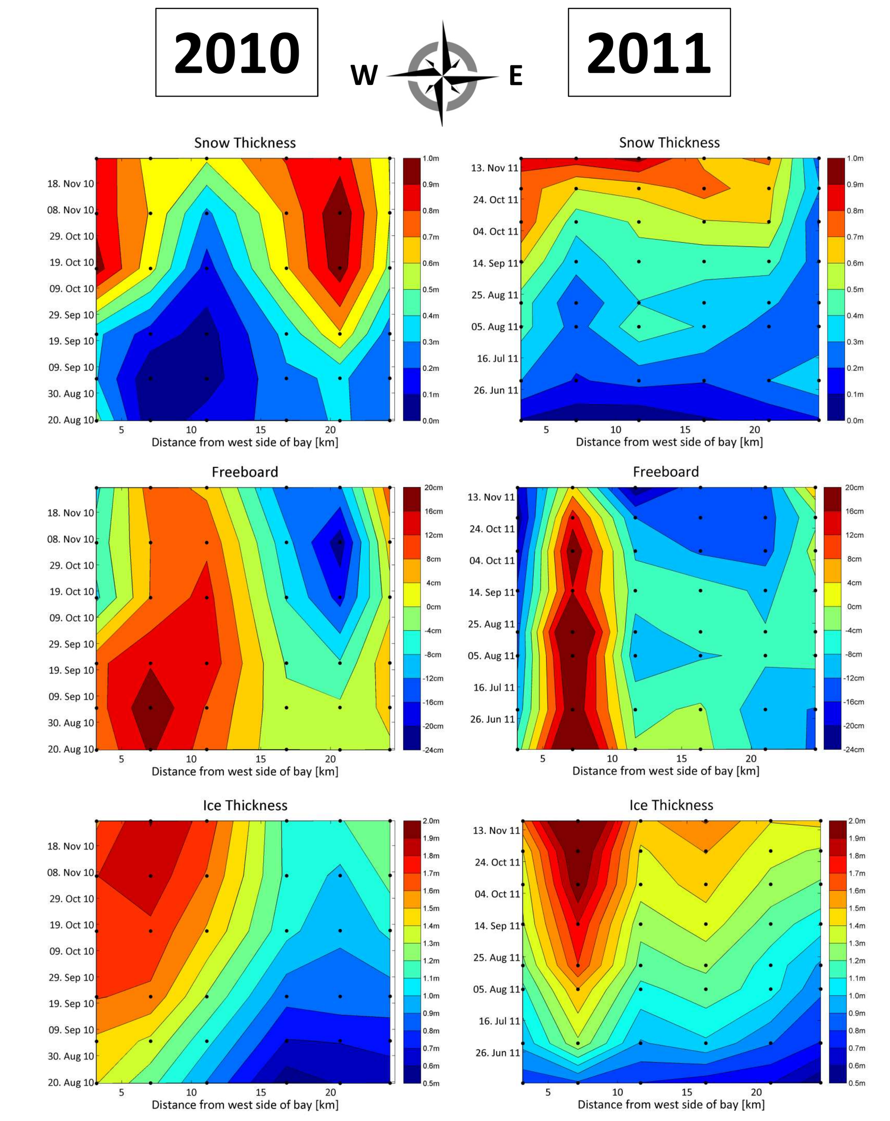
- Platelet ice accounts for up to 60 % of total sea-ice mass
- Two different layers: consolidated platelet ice (frozen into the structure) and unconsolidated platelet layer below the solid sea ice

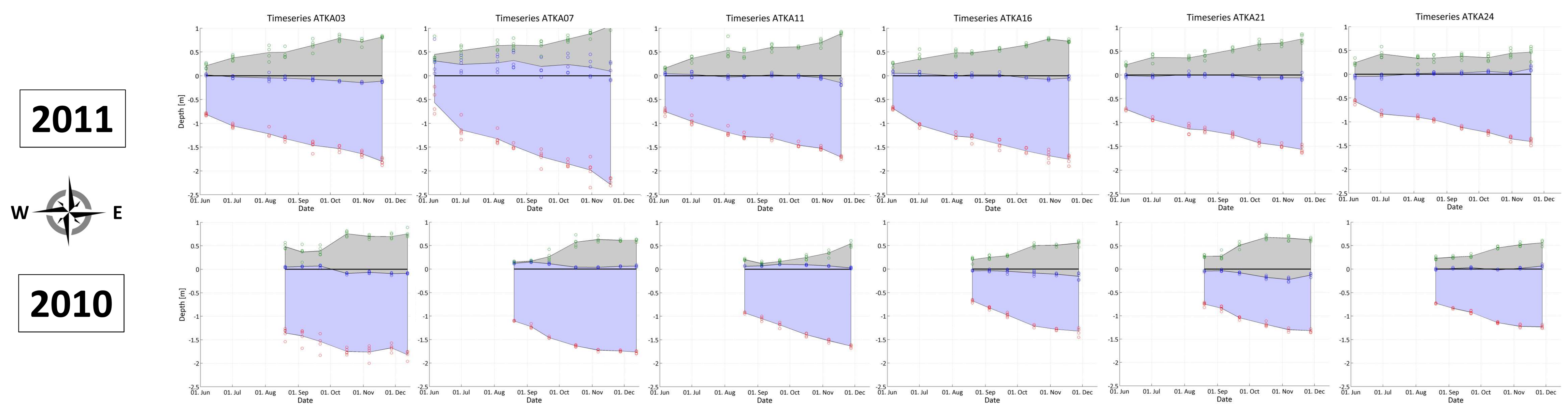
Area of interest: Atka Bay land-fast ice



TerraSAR-X image of Atka Bay with stations in 2010 (white) and 2011 (black), where regular **manual thickness measurements** take place. Station names (e.g. ATKA03) refer to the distance to the western ice-shelf edge. The profile was relocated in 2011 in order to reduce the likeliness of an early ice break-up at ATKA07 as in 2010.
In 2011, an additional **weather station** and a **thermistor chain** were deployed between ATKA03 and the ice-shelf edge. The colored circles show **electromagnetic thickness measurements** (snow + ice) on 18 November 2011.

Manual drillings





Top: Hovmöller diagrams of snow and ice thicknesses and freeboard across Atka Bay (Hoppmann et al., 2011). Note the different time (y-) axes in 2010 and 2011.
Left: time series of data at the different stations

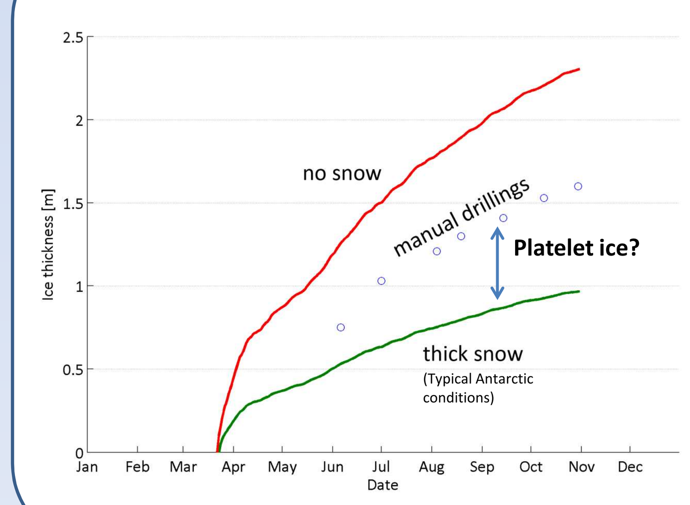
Observations:

- Sea ice in the western part is generally about 0.5m thicker than in the East.
- Local variability is very high in the West
- Snow cover is heterogeneous
- Freeboard is more negative in the East due to thinner ice

Possible explanations:

1. Differences in snow accumulation due to prevailing winds from the East
2. Differences in ocean currents (temperature, transport/formation of ice platelets)

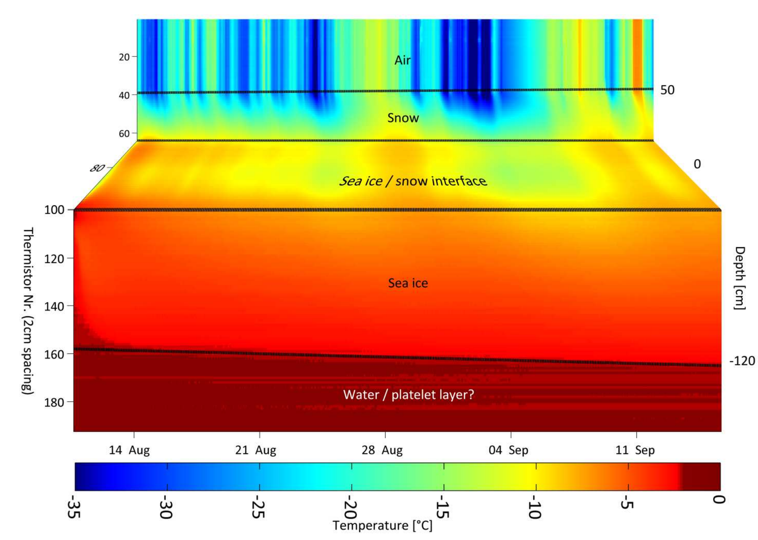
Thermodynamic growth model



A simple Freezing-Degree-Day model was applied to compare sea-ice thickness as it would result from pure thermodynamic growth with thickness measured in the field (including platelet ice contribution) in 2011.

The model clearly shows the big influence of snow on ice growth and gives a first estimate of consolidated platelet-ice thickness.

Thermistor chain data



Temperatures measured by a thermistor chain deployed between ATKA03 and the ice-shelf edge. Due to technical problems, data is only available between 10 August and 15 September 2011. Air/snow, snow/ice and ice/water interfaces are visible around 50 cm, 0 cm and -120 cm. Below the solid sea ice, a layer of ice platelets might be recognizable.

Acknowledgements

We are most grateful to **Holger Schmithüsen, Jölund Asseng and the Neumayer III wintering teams of 2010 & 2011** for gathering all the data shown on this poster. Special thanks goes to Holger Schmithüsen for preparing some of the figures. We thank **Angelika Humbert** (Univ. of Hamburg) for providing high resolution TerraSAR-X satellite images, courtesy of Deutsches Zentrum für Luft- und Raumfahrt. We highly acknowledge **Gert König-Langlo, Bernd Loose, Gerhard Dieckmann, Lars Kindermann and other colleagues at AWI** for their great support in every respect. The project was partly funded through the **German Research Council** (DFG) in its priority program "Antarctic Research with comparative investigations in Arctic ice areas" (SPP1158, NI 1092/2).

References: **[1] Günther , S., and Dieckmann , G.S.:** *Antarctic Science 11 (3): 305-315, 1999* **[2] Günther , S.:** *Dissertation, 1999* **[3] Hoppmann, M., Nicolaus, M., and Schmithüsen, H.:** doi:10.1594/PANGAEA.762681, 2011 **[4] Heil, P., Gerland, S., and Granskog, M. A.:** The Cryosphere Discuss., doi:10.5194/tcd-5-2437-2011